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FOUR  
LETTERS

FROM

SIR ISAAC NEWTON

TO

DR. BENTLEY.

[Price One Shilling.]

THE UNIVERSITY OF CHICAGO

PHILOSOPHY

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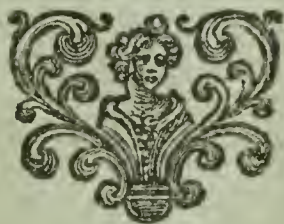
DOCTOR BENTLEY.

CONTAINING

SOME ARGUMENTS

IN

PROOF of a DEITY.



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THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT

REPORT ON THE PROGRESS OF WORK

1911

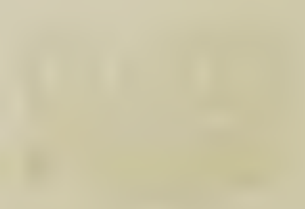
BY

ROBERT A. MILLIKAN

AND

ET AL.

CHICAGO, ILL., 1911



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# LETTERS, &c.

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## LETTER I.

*To the Reverend Dr. RICHARD BENTLEY, at the Bishop of Worcester's House in Park-street, Westminster.*

SIR,

**W**HEN I wrote my Treatise about our System, I had an Eye upon such Principles as might work with considering Men, for the Belief of a Deity, and nothing can rejoice me more than to find it useful for that Purpose. But if I

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have

have done the Public any Service this way, it is due to nothing but Industry and patient Thought.

As to your first Query, it seems to me that if the Matter of our Sun and Planets, and all the Matter of the Universe, were evenly scattered throughout all the Heavens, and every Particle had an innate Gravity towards all the rest, and the whole Space, throughout which this Matter was scattered, was but finite; the Matter on the outside of this Space would by its Gravity tend towards all the Matter on the inside, and by consequence fall down into the middle of the whole Space, and there compose one great spherical Mass. But if the Matter was evenly disposed throughout an infinite Space, it could never convene into one Mass, but some of it would convene into one Mass and some into another, so as to make an infinite Number of great Masses, scattered at great Distances from one to another  
through-

throughout all that infinite Space. And thus might the Sun and fixt Stars be formed, supposing the Matter were of a lucid Nature. But how the Matter should divide itself into two sorts, and that Part of it, which is fit to compose a shining Body, should fall down into one Mass and make a Sun, and the rest, which is fit to compose an opaque Body, should coalesce, not into one great Body, like the shining Matter, but into many little ones; or if the Sun at first were an opaque Body like the Planets, or the Planets lucid Bodies like the Sun, how he alone should be changed into a shining Body, whilst all they continue opaque, or all they be changed into opaque ones, whilst he remains unchanged, I do not think explicable by meer natural Causes, but am forced to ascribe it to the Counsel and Contrivance of a voluntary Agent.

The same Power, whether natural or supernatural, which placed the Sun in

the Center of the six primary Planets, placed *Saturn* in the Center of the Orbs of his five secondary Planets, and *Jupiter* in the Center of his four secondary Planets, and the Earth in the Center of the Moon's Orb; and therefore had this Cause been a blind one, without Contrivance or Design, the Sun would have been a Body of the same kind with *Saturn*, *Jupiter*, and the Earth, that is, without Light and Heat. Why there is one Body in our System qualified to give Light and Heat to all the rest, I know no Reason, but because the Author of the System thought it convenient; and why there is but one Body of this kind I know no Reason, but because one was sufficient to warm and enlighten all the rest. For the *Cartesian* Hypothesis of Suns losing their Light, and then turning into Comets, and Comets into Planets, can have no Place in my System, and is plainly erroneous; because it is certain that as often as they appear to us, they descend into the System  
of



of our Planets, lower than the Orb of *Jupiter*, and sometimes lower than the Orbs of *Venus* and *Mercury*, and yet never stay here, but always return from the Sun with the same Degrees of Motion by which they approached him.

To your second Query, I answer, that the Motions which the Planets now have could not spring from any natural Cause alone, but were impressed by an intelligent Agent. For since Comets descend into the Region of our Planets, and here move all manner of ways, going sometimes the same way with the Planets, sometimes the contrary way, and sometimes in cross ways, in Planes inclined to the Plane of the Ecliptick, and at all kinds of Angles, 'tis plain that there is no natural Cause which could determine all the Planets, both primary and secondary, to move the same way and in the same Plane, without any considerable Variation: This must have been the Effect

fect of Counsel. Nor is there any natural Cause which could give the Planets those just Degrees of Velocity, in Proportion to their Distances from the Sun, and other central Bodies, which were requisite to make them move in such concentrick Orbs about those Bodies. Had the Planets been as swift as Comets, in Proportion to their Distances from the Sun (as they would have been, had their Motion been caused by their Gravity, whereby the Matter, at the first Formation of the Planets, might fall from the remotest Regions towards the Sun) they would not move in concentrick Orbs, but in such eccentric ones as the Comets move in. Were all the Planets as swift as *Mercury*, or as slow as *Saturn* or his Satellites; or were their several Velocities otherwise much greater or less than they are, as they might have been had they arose from any other Cause than their Gravities; or had the Distances from the Centers about which they move, been greater or  
 less

less than they are with the same Velocities ; or had the Quantity of Matter in the Sun, or in *Saturn*, *Jupiter*, and the Earth, and by consequence their gravitating Power been greater or less than it is ; the primary Planets could not have revolved about the Sun, nor the secondary ones about *Saturn*, *Jupiter*, and the Earth, in concentrick Circles as they do, but would have moved in Hyperbolas, or Parabolas, or in Ellipses very eccentric. To make this System therefore, with all its Motions, required a Cause which understood, and compared together, the Quantities of Matter in the several Bodies of the Sun and Planets, and the gravitating Powers resulting from thence ; the several Distances of the primary Planets from the Sun, and of the secondary ones from *Saturn*, *Jupiter*, and the Earth ; and the Velocities with which these Planets could revolve about those Quantities of Matter in the central Bodies ; and to compare and adjust all these Things

Things together, in so great a Variety of Bodies, argues that Cause to be not blind and fortuitous, but very well skilled in Mechanicks and Geometry.

To your third Query, I answer, that it may be represented that the Sun may, by heating those Planets most which are nearest to him, cause them to be better concocted, and more condensed by that Concoction. But when I consider that our Earth is much more heated in its Bowels below the upper Crust by subterraneous Fermentations of mineral Bodies than by the Sun, I see not why the interior Parts of *Jupiter* and *Saturn* might not be as much heated, concocted, and coagulated by those Fermentations as our Earth is; and therefore this various Density should have some other Cause than the various Distances of the Planets from the Sun. And I am confirmed in this Opinion by considering, that the Planets of *Jupiter* and *Saturn*, as they are rarer  
than

than the rest, so they are vastly greater, and contain a far greater Quantity of Matter, and have many Satellites about them; which Qualifications surely arose not from their being placed at so great a Distance from the Sun, but were rather the Cause why the Creator placed them at great Distance. For by their gravitating Powers they disturb one another's Motions very sensibly, as I find by some late Observations of Mr. *Flamsteed*, and had they been placed much nearer to the Sun and to one another, they would by the same Powers have caused a considerable Disturbance in the whole System.

To your fourth Query, I answer, that in the Hypothesis of Vortices, the Inclination of the Axis of the Earth might, in my Opinion, be ascribed to the Situation of the Earth's Vortex before it was absorbed by the neighbouring Vortices, and the Earth turned from a Sun to a

Comet; but this Inclination ought to decrease constantly in Compliance with the Motion of the Earth's Vortex, whose Axis is much less inclined to the Ecliptick, as appears by the Motion of the Moon carried about therein. If the Sun by his Rays could carry about the Planets, yet I do not see how he could thereby effect their diurnal Motions.

Lastly, I see nothing extraordinary in the Inclination of the Earth's Axis for proving a Deity, unless you will urge it as a Contrivance for Winter and Summer, and for making the Earth habitable towards the Poles; and that the diurnal Rotations of the Sun and Planets, as they could hardly arise from any Cause purely mechanical, so by being determined all the same way with the annual and menstrual Motions, they seem to make up that Harmony in the System, which, as I explained above, was the Effect of Choice rather than Chance.

There

There is yet another Argument for a Deity, which I take to be a very strong one, but till the Principles on which it is grounded are better received, I think it more advisable to let it sleep.

*I am,*

*Your most humble Servant,*

*to command,*

Cambridge,  
Decemb. 10, 1692.

IS. NEWTON,





## L E T T E R II.

*For Mr. BENTLEY, at the Palace  
at Worcester.*

S I R,

**I** Agree with you, that if Matter evenly diffused through a finite Space, not spherical, should fall into a solid Mass, this Mass would affect the Figure of the whole Space, provided it were not soft, like the old Chaos, but so hard and solid from the Beginning, that the Weight of its protuberant Parts could not make it yield to their Pressure. Yet by Earthquakes loosening the Parts of this Solid, the Protuberances might sometimes sink a little by their Weight, and thereby the Mass might, by Degrees, approach a spherical Figure.

The

The Reason why Matter evenly scattered through a finite Space would convene in the midst, you conceive the same with me ; but that there should be a central Particle, so accurately placed in the middle, as to be always equally attracted on all Sides, and thereby continue without Motion, seems to me a Supposition fully as hard as to make the sharpest Needle stand upright on its Point upon a Looking-Glass. For if the very mathematical Center of the central Particle be not accurately in the very mathematical Center of the attractive Power of the whole Mass, the Particle will not be attracted equally on all Sides. And much harder it is to suppose all the Particles in an infinite Space should be so accurately poised one among another, as to stand still in a perfect Equilibrium. For I reckon this as hard as to make not one Needle only, but an infinite number of them (so many as there are Particles in an infinite Space) stand accurately poised upon their Points.

Points. Yet I grant it possible, at least by a divine Power; and if they were once to be placed, I agree with you that they would continue in that Posture without Motion for ever, unless put into new Motion by the same Power. When therefore I said, that Matter evenly spread through all Space, would convene by its Gravity into one or more great Masses, I understand it of Matter not resting in an accurate Poise.

But you argue, in the next Paragraph of your Letter, that every Particle of Matter in an infinite Space, has an infinite Quantity of Matter on all Sides, and by consequence an infinite Attraction every way, and therefore must rest in Equilibrium, because all Infinities are equal. Yet you suspect a Paralogism in this Argument; and I conceive the Paralogism lies in the Position, that all Infinities are equal. The generality of Mankind consider Infinities no other ways than indefinitely; and

and in this Sense, they say all Infinites are equal; tho' they would speak more truly if they should say, they are neither equal nor unequal, nor have any certain Difference or Proportion one to another. In this Sense therefore, no Conclusions can be drawn from them, about the Equality, Proportions, or Differences of Things, and they that attempt to do it usually fall into Paralogisms. So when Men argue against the infinite Divisibility of Magnitude, by saying, that if an Inch may be divided into an infinite Number of Parts, the Sum of those Parts will be an Inch; and if a Foot may be divided into an infinite Number of Parts, the Sum of those Parts must be a Foot, and therefore since all Infinites are equal, those Sums must be equal, that is, an Inch equal to a Foot.

The Falseness of the Conclusion shews an Error in the Premises, and the Error lies in the Position, that all Infinites are  
equal.

equal. There is therefore another Way of considering Infinites used by Mathematicians, and that is, under certain definite Restrictions and Limitations, whereby Infinites are determined to have certain Differences or Proportions to one another. Thus Dr. *Wallis* considers them in his *Arithmetica Infinitorum*, where by the various Proportions of infinite Sums, he gathers the various Proportions of infinite Magnitudes: Which way of arguing is generally allowed by Mathematicians, and yet would not be good were all Infinites equal. According to the same way of considering Infinites, a Mathematician would tell you, that tho' there be an infinite Number of infinite little Parts in an Inch, yet there is twelve times that Number of such Parts in a Foot, that is, the infinite Number of those Parts in a Foot is not equal to, but twelve Times bigger than the infinite Number of them in an Inch. And so a Mathematician will tell you, that if a

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Body

Body stood in Equilibrio between any two equal and contrary attracting infinite Forces; and if to either of these Forces you add any new finite attracting Force, that new Force, how little soever, will destroy their Equilibrium, and put the Body into the same Motion into which it would put it were those two contrary equal Forces but finite, or even none at all; so that in this Case the two equal Infinites by the Addition of a Finite to either of them, become unequal in our ways of Reckoning; and after these ways we must reckon, if from the Considerations of Infinites we would always draw true Conclusions.

To the last Part of your Letter, I answer, First, that if the Earth (without the Moon) were placed any where with its Center in the *Orbis Magnus*, and stood still there without any Gravitation or Projection, and there at once were infused into it, both a gravitating Energy towards  
the

the Sun, and a transverse Impulse of a just Quantity moving it directly in a Tangent to the *Orbis Magnus*; the Compounds of this Attraction and Projection would, according to my Notion, cause a circular Revolution of the Earth about the Sun. But the transverse Impulse must be a just Quantity; for if it be too big or too little, it will cause the Earth to move in some other Line. Secondly, I do not know any Power in Nature which would cause this transverse Motion without the divine Arm. *Blondel* tells us somewhere in his Book of Bombs, that *Plato* affirms, that the Motion of the Planets is such, as if they had all of them been created by God in some Region very remote from our System, and let fall from thence towards the Sun, and so soon as they arrived at their several Orbs, their Motion of falling turned aside into a transverse one. And this is true, supposing the gravitating Power of the Sun was double

at that Moment of Time in which they all arrive at their several Orbs ; but then the divine Power is here required in a double respect, namely, to turn the descending Motions of the falling Planets into a side Motion, and at the same time to double the attractive Power of the Sun. So then Gravity may put the Planets into Motion, but without the divine Power it could never put them into such a circulating Motion as they have about the Sun ; and therefore, for this, as well as other Reasons, I am compelled to ascribe the Frame of this System to an intelligent Agent.

You sometimes speak of Gravity as essential and inherent to Matter. Pray do not ascribe that Notion to me ; for the Cause of Gravity is what I do not pretend to know, and therefore would take more Time to consider of it.

I fear what I have said of Infinites, will seem obscure to you ; but it is enough if  
you



you understand, that Infinites when considered absolutely without any Restriction or Limitation, are neither equal nor unequal, nor have any certain Proportion one to another, and therefore the Principle that all Infinites are equal, is a precarious one.

*Sir, I am,*

*Your most humble Servant,*

Trinity College,  
Jan. 17, 1692-3.

IS. NEWTON.

LET-



## L E T T E R III.

*For Mr. BENTLEY, at the Palace  
at Worcester.*

S I R,

**B**Ecause you desire Speed, I will answer your Letter with what Brevity I can. In the six Positions you lay down in the Beginning of your Letter, I agree with you. Your assuming the *Orbis Magnus* 7000 Diameters of the Earth wide, implies the Sun's horizontal Parallax to be half a Minute. *Flamsteed* and *Cassini* have of late observed it to be about 10", and thus the *Orbis Magnus* must be 21,000, or in a rounder Number 20,000 Diameters of the Earth wide. Either Computation I think

think will do well, and I think it not worth while to alter your Numbers.

In the next Part of your Letter you lay down four other Positions, founded upon the six first. The first of these four seems very evident, supposing you take Attraction so generally as by it to understand any Force by which distant Bodies endeavour to come together without mechanical Impulse. The second seems not so clear ; for it may be said, that there might be other Systems of Worlds before the present ones, and others before those, and so on to all past Eternity, and by consequence, that Gravity may be co-eternal to Matter, and have the same Effect from all Eternity as at present, unless you have somewhere proved that old Systems cannot gradually pass into new ones ; or that this System had not its Original from the exhaling Matter of former decaying Systems, but from a Chaos of Matter evenly dispersed

dispersed throughout all Space ; for something of this Kind, I think, you say was the Subject of your sixth Sermon ; and the Growth of new Systems out of old ones, without the Mediation of a divine Power, seems to me apparently absurd.

The last Clause of the second Position I like very well. It is inconceivable, that inanimate brute Matter should, without the Mediation of something else, which is not material, operate upon, and affect other Matter without mutual Contact, as it must be, if Gravitation in the Sense of *Epicurus*, be essential and inherent in it. And this is one Reason why I desired you would not ascribe innate Gravity to me. That Gravity should be innate, inherent and essential to Matter, so that one Body may act upon another at a Distance thro' a *Vacuum*, without the Mediation of any thing else, by and through which their Action and Force may be conveyed from

E one

one to another, is to me so great an Absurdity, that I believe no Man who has in philosophical Matters a competent Faculty of thinking, can ever fall into it. Gravity must be caused by an Agent acting constantly according to certain Laws ; but whether this Agent be material or immaterial, I have left to the Consideration of my Readers.

Your fourth Assertion, that the World could not be formed by innate Gravity alone, you confirm by three Arguments. But in your first Argument you seem to make a *Petitio Principii* ; for whereas many ancient Philosophers and others, as well Theists as Atheists, have all allowed, that there may be Worlds and Parcels of Matter innumerable or infinite, you deny this, by representing it as absurd as that there should be positively an infinite arithmetical Sum or Number, which is a Contradiction *in Terminis* ; but you do not  
 prove

prove it as absurd. Neither do you prove, that what Men mean by an infinite Sum or Number, is a Contradiction in Nature; for a Contradiction *in Terminis* implies no more than an Impropriety of Speech. Those things which Men understand by improper and contradictory Phrases, may be sometimes really in Nature without any Contradiction at all: a Silver Inkhorn, a Paper Lanthorn, an Iron Whetstone, are absurd Phrases, yet the Things signified thereby, are really in Nature. If any Man should say, that a Number and a Sum, to speak properly, is that which may be numbered and summed, but Things infinite are numberless, or, as we usually speak, innumerable and sumless, or insummable, and therefore ought not to be called a Number or Sum, he will speak properly enough, and your Argument against him will, I fear, lose its Force. And yet if any Man shall take the Words, Number and Sum, in a larger Sense, so

as to understand thereby Things, which in the proper way of speaking are numberless and sumless (as you seem to do when you allow an infinite Number of Points in a Line) I could readily allow him the Use of the contradictory Phrases of innumerable Number, or sumless Sum, without inferring from thence any Absurdity in the Thing he means by those Phrases. However, if by this, or any other Argument, you have proved the Finiteness of the Universe, it follows, that all Matter would fall down from the Out-sides, and convene in the Middle. Yet the Matter in falling might concrete into many round Masses, like the Bodies of the Planets, and these by attracting one another, might acquire an Obliquity of Descent, by means of which they might fall, not upon the great central Body, but upon the Side of it, and fetch a Compass about, and then ascend again by the same Steps and Degrees of Motion and Velocity with



with which they descended before, much after the Manner that the Comets revolve about the Sun; but a circular Motion in concentrick Orbs about the Sun, they could never acquire by Gravity alone.

And tho' all the Matter were divided at first into several Systems, and every System by a divine Power constituted like ours; yet would the Outside Systems descend towards the Middlemost; so that this Frame of Things could not always subsist without a divine Power to conserve it, which is the second Argument; and to your third I fully assent.

As for the Passage of *Plato*, there is no common Place from whence all the Planets being let fall, and descending with uniform and equal Gravities (as *Galileo* supposes) would at their Arrival to their several Orbs acquire their several Velocities, with which they now revolve in  
 them.

them. If we suppose the Gravity of all the Planets towards the Sun to be of such a Quantity as it really is, and that the Motions of the Planets are turned upwards, every Planet will ascend to twice its Height from the Sun. *Saturn* will ascend till he be twice as high from the Sun as he is at present, and no higher; *Jupiter* will ascend as high again as at present, that is, a little above the Orb of *Saturn*; *Mercury* will ascend to twice his present Height, that is, to the Orb of *Venus*; and so of the rest; and then by falling down again from the Places to which they ascended, they will arrive again at their several Orbs with the same Velocities they had at first, and with which they now revolve.

But if so soon as their Motions by which they revolve are turned upwards, the gravitating Power of the Sun, by which their Ascent is perpetually retarded,  
 be

be diminished by one half, they will now ascend perpetually, and all of them at all equal Distances from the Sun will be equally swift. *Mercury* when he arrives at the Orb of *Venus*, will be as swift as *Venus*; and he and *Venus*, when they arrive at the Orb of the *Earth*, will be as swift as the *Earth*; and so of the rest. If they begin all of them to ascend at once, and ascend in the same Line, they will constantly in ascending become nearer and nearer together, and their Motions will constantly approach to an Equality, and become at length slower than any Motion assignable. Suppose therefore, that they ascended till they were almost contiguous, and their Motions inconsiderably little, and that all their Motions were at the same Moment of Time turned back again; or, which comes almost to the same Thing, that they were only deprived of their Motions, and let fall at that Time, they would all at once arrive at their several Orbs, each with

with the Velocity it had at first; and if their Motions were then turned Side-ways, and at the same Time the gravitating Power of the Sun doubled, that it might be strong enough to retain them in their Orbs, they would revolve in them as before their Ascent. But if the gravitating Power of the Sun was not doubled, they would go away from their Orbs into the highest Heavens in parabolical Lines. These Things follow from my *Princ. Math. Lib. i. Prop. 33, 34, 36, 37.*

I thank you very kindly for your designed Present, and rest

*Your most*

*humble Servant*

*to command,*

Cambridge,  
Feb. 25, 1692-3.

IS. NEWTON.

## L E T T E R IV.

*To Mr. BENTLEY, at the Palace  
at Worcester.*

S I R,

**T**HE Hypothesis of deriving the Frame of the World by mechanical Principles from Matter evenly spread through the Heavens, being inconsistent with my System, I had considered it very little before your Letters put me upon it, and therefore trouble you with a Line or two more about it, if this comes not too late for your Use.

In my former I represented that the diurnal Rotations of the Planets could not be derived from Gravity, but required a divine Arm to impress them. And tho'

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Gravity

Gravity might give the Planets a Motion of Descent towards the Sun, either directly or with some little Obliquity, yet the transverse Motions by which they revolve in their several Orbs, required the divine Arm to impress them according to the Tangents of their Orbs. I would now add, that the Hypothesis of Matter's being at first evenly spread through the Heavens, is, in my Opinion, inconsistent with the Hypothesis of innate Gravity, without a supernatural Power to reconcile them, and therefore it infers a Deity. For if there be innate Gravity, it is impossible now for the Matter of the Earth and all the Planets and Stars to fly up from them, and become evenly spread throughout all the Heavens, without a supernatural Power; and certainly that which can never be hereafter without a supernatural Power, could never be heretofore without the same Power.

You

You queried, whether Matter evenly spread throughout a finite Space, of some other Figure than spherical, would not in falling down towards a central Body, cause that Body to be of the same Figure with the whole Space, and I answered, yes. But in my Answer it is to be supposed that the Matter descends directly downwards to that Body, and that that Body has no diurnal Rotation.

This, Sir, is all I would add to my former Letters.

*I am,*

*Your most humble*

*Servant,*

Cambridge,  
Feb. 11, 1693.

IS. NEWTON.

F I N I S.

The first of these is the  
the second is the  
the third is the  
the fourth is the  
the fifth is the  
the sixth is the  
the seventh is the  
the eighth is the  
the ninth is the  
the tenth is the

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